Scientia
Publica
Media

Review Article

Trends and Development of Research on Flipped Classroom in Education: A Bibliometric Analysis from 2012 to 2024

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Abstract
Nowadays, advancements in ICT have positively impacted education. This bibliometric study examines trends and developments in research on flipped classrooms in education from 2012 to 2024, focusing on the impact of technological advancements in supporting student-centered learning. The flipped classroom approach allows students to learn course materials independently before class sessions, where active discussions, problem-solving, and collaboration become the primary activities. Using data from Scopus, 1,580 relevant research articles were analyzed to reveal publication trends, influential contributions, and key themes. The analysis highlights the role of flipped classrooms in enhancing students' critical thinking, independent learning, and intrinsic motivation. Findings indicate a growing research interest in this model, particularly in higher education and science disciplines, with significant growth during and after the COVID-19 pandemic, with an impressive annual growth rate of 53.34%. These publications involved contributions from 4,226 authors, with Wang Y emerging as the most prolific author. The documents were distributed across 639 different sources, with BMC Medical Education recognized as the most productive source. In terms of geographical distribution, the United States led with the highest number of publications. The University of California was identified as the institution with the largest number of publications. The most frequently used keywords in these studies included students, teaching, education, curriculum, human, learning, humans, article, medical, and male. This study provides insights into collaborative networks, influential publications, and the latest research trends, offering guidance for educators, policymakers, and researchers in planning future studies and implementing flipped classrooms effectively.

Keywords: Flipped Classroom, Student-Centered Learning, Bibliometric Analysis, Independent Learning, Scopus

1. INTRODUCTION

In today's digital era, advancements in ICT have positively impacted education (Chasokela, 2025; Handayani, 2025; Sulastri, 2025). Videos, online learning platforms, and interactive applications enable more flexible learning. Technology opens other factors that support learning, such as students' engagement with learning materials, varied learning resources, and self-directed learning. Consequently, learning processes are expected to improve (Selvan & Kalaiyarasan, 2024; Timotheou et al., 2023; Uzorka & Olaniyan, 2025). Technological advancements are often the result of a series of evolutionary steps rather than major breakthroughs. Breakthroughs like the invention of the transistor are rare and usually emerge from the introduction of new knowledge from different fields (Dosi & Nelson, 2013). The integration of information technology and multimedia has enhanced the quality of education and accelerated the learning process, especially in second language acquisition (Din et al., 2024).

The flipped classroom is described as a learning method that reverses the roles of in-class and out-of-class activities (Melati & Hadinugrahaningsih, 2024; Rakhmalinda, 2024). In this approach, learning

materials such as videos, readings, or preliminary assignments are prepared and studied by students outside of class beforehand. During face-to-face class sessions, time is used for active discussions, problem-solving, or in-depth collaborative activities. (O'Flaherty & Phillips, 2015). This approach, which falls under blended learning, allows students to be more independent in understanding theory before coming to class. Consequently, when in class, they can collaborate with classmates and engage in practical problem-solving activities (Strayer, 2012). Students have more control over their learning pace through video lectures, and in the classroom, they participate in activities that strengthen critical thinking skills (McLaughlin et al., 2014). The flipped classroom also allows for greater differentiation of instruction, enhancing students' motivation to learn (Davies et al., 2013).

The flipped classroom is an innovative pedagogical approach that focuses on student-centered learning. In research by (Gilboy et al., 2015), it is explained that this method enhances student engagement and enables more structured teaching by utilizing all levels of Bloom's taxonomy. The flipped classroom creates space for deeper engagement and collaboration compared to traditional teaching methods. It increases students' active participation in class through discussions, problem-solving, and peer collaboration (Kim et al., 2014). The flipped classroom significantly enhances students' critical thinking skills compared to conventional methods, fostering greater engagement and deeper understanding.

There was a notable rise in the number of publications on the flipped classroom starting in 2013, peaking in recent years, with a total of 2,194 articles reviewed from 2007 to 2021 (Del Arco et al., 2022). Bibliometric analysis can identify trends in flipped classroom research, including emerging subtopics, countries with high research contributions, and journals that frequently publish related studies (Zainuddin & Halili, 2016). Bibliometrics enables the analysis of collaboration networks among researchers from different countries, thereby identifying collaborative contributions and significant partnerships in flipped classroom research (Bond, 2020). Bibliometric analysis highlights influential authors and articles in flipped classroom research, helping new researchers access key literature and identify prominent figures to understand the theoretical foundations of the field (Bishop & Verleger, 2013). Bibliometrics evaluates the impact of flipped classroom research through citation metrics, demonstrating the influence of studies in shaping understanding and methodologies within the field (Akçayır & Akçayır, 2018). Bibliometric analysis is highly beneficial in illustrating publication patterns, researcher networks, and emerging conceptual trends in the field of flipped classrooms.

The emerging trend indicates a significant increase in publications and research related to the flipped classroom from 2012 to 2022, peaking in 2022. This reflects a growing interest among researchers across various countries, particularly in the United States and China (Rakhmalinda, 2024). Consequently, further research could delve deeper into how the flipped classroom approach allows students to have greater control over their learning journey. In this model, students are given the opportunity to independently access learning materials before face-to-face sessions, which means they can learn in the most natural way that aligns with their learning pace and style. This not only fosters student independence but also enhances intrinsic motivation to learn. As mentioned above, when students feel a sense of ownership over their learning process, they become more invested in the material and are more motivated to achieve academic goals.

This study aims to explore in greater depth the impact of implementing the flipped classroom in facilitating students' control over their learning process. It also analyzes how the flipped classroom can enhance self-directed learning and intrinsic motivation in students. Therefore, the purpose of this study is to identify best practices in operating an effective flipped classroom that can improve student engagement and learning outcomes across various disciplines.

This study is significantly useful for various stakeholders. For teachers and lecturers, this research provides insights and new approaches for the effective implementation of the flipped classroom to enhance the quality of management and student engagement activities. Additionally, the study offers insights into the potential use of technology to improve the dynamics and interactivity of the learning process. For students, this research enables them to understand the importance of independence in learning, which enhances their intrinsic motivation to a more psychologically satisfying level, leading to better academic outcomes. Moreover, students will gain a more unique learning experience that is tailored to their own effective learning styles. For educational institutions, this study provides concrete evidence of the effectiveness of the flipped classroom, which can be used in shaping policies and designing more student-oriented curricula, as well as helping institutions understand the dynamics and challenges of modern education in the context of technology. Finally, for researchers and academics, this study offers valuable

references for the development of flipped classroom research and technology-based education, along with bibliometric analysis that can assist new researchers.

      This study involves bibliometric analysis to identify and visualize various research profiles and trends related to the flipped classroom field. This study aims to offer meaningful insights to researchers, educational institutions, educators, and librarians regarding the future trends in flipped classroom research. These insights will assist in planning their own research agendas and contribute to further developments in this field. At the same time, policymakers can take into account the findings of this study to make decisions that will support research in this rapidly evolving field. They can make informed decisions based on a better understanding of previous research, ensuring that policies remain up-to-date and aligned with the latest trends. The following are the research questions:

1.1. Research Questions (RQs)

RQ1: How does the implementation of the flipped classroom affect students' control over their learning process?
RQ2: What is the impact of the flipped classroom on students' independence in learning?
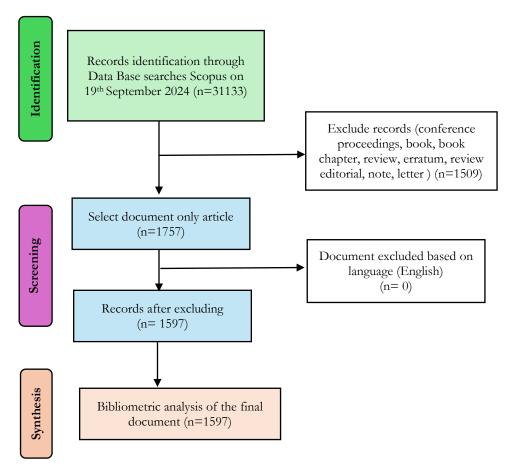RQ3: To what extent can the flipped classroom enhance students' intrinsic motivation to learn independently?

Identification

Records identification through Data Base searches Scopus on 19th September 2024 (n=31133)

Exclude records (conference proceedings, book, book chapter, review, erratum, review editorial, note, letter) (n=1509)

Screening

Select document only article (n=1757)

Document excluded based on language (English) (n= 0)

Records after excluding (n= 1597)

Synthesis

Bibliometric analysis of the final document (n=1597)

Figure 1. Article Selection Process

2. DATA AND METHOD

      This study uses a bibliometric approach to map the development of interest in flipped classroom research. By analyzing publication data from the Scopus database, the study identifies the key topics currently drawing the attention of experts. Dynamic topic modeling allows for measuring the extent to

which individual researchers align with ongoing trends, categorizing their focus into mainstream, short-term, and long-term areas (Meng et al., 2022). The results of this study are expected to provide deeper insights into the dynamics of knowledge development in the field of scientific creativity, as well as offer recommendations for future research.

2.1. Article Selection Process

The data extraction process from the Scopus bibliography was conducted on September 19, 2024, using the following search string: TITLE-ABS-KEY ("flipped classroom" OR "inverted classroom") AND ("university" OR "college" OR "higher education"), adapted from the approach used by Limaymanta et al. (2021). The search was limited to publications from 2012 to 2024, as the year 2012 marks a notable rise in flipped classroom research and is widely recognized as a turning point in the evolution of this pedagogical approach. Adapted from the article by Cesar H. Limaymanta and colleagues, the steps taken began with filtering based on the specified years (2012-2024) and restricting the selection of articles due to the large number of publication types. Articles were selected as they are the most prevalent and representative type of publication, featuring original research suitable for analysis and comparison through bibliometric methods and indicators. Moreover, the selection was limited to works written in English. Subsequently, several articles were further selected to remove duplicates and ensure their relevance to the research topic. After this, 1,580 articles were included and reviewed in the bibliometric study. The complete data can be seen in Figure 1.

2.2. Data Analysis

The included file was extracted as a Microsoft Excel (.bib) or BibTeX bibliographical database file containing variables such as author names, affiliations, titles, journal names, countries, and keywords. The file was then analyzed descriptively in accordance with the research questions. The Bibliometrix software was used to visualize the data and support the analysis of various bibliometric indicators, such as the number of publications, citation metrics, author collaboration networks, and the emergence of keywords (Prahani et al., 2024). This capability is essential for understanding scientific productivity and collaboration. The software also tracks cross-disciplinary publications, providing a comprehensive view of how research in the flipped classroom is evolving across different fields (Bornmann et al., 2021). Bibliometric data includes quantitative information that describes the characteristics and impact of academic publications, useful for identifying research trends and author contributions. For example, a bibliometric analysis of learning models in physical education shows an increase in publications from 2012 to 2023, with Indonesia emerging as a leader in research contributions (Triansyah et al., 2024). By analyzing keyword frequency and co-occurrence, researchers can identify central themes within a field. Keywords serve as primary indicators of a document's content, summarizing its main ideas. This study uses Scopus because it covers more active journals than the Web of Science (WoS), with a total of 20,346 journals compared to 13,605 in WoS (Mongeon, 2016). Scopus provides comprehensive profiles for authors and institutions, generated through a combination of advanced profiling algorithms and manual curation, ensuring high levels of accuracy and coverage (Baas et al., 2020). The PRISMA flow diagram is an essential tool for systematically documenting the literature selection process in systematic reviews (Moher et al., 2010). This tool enhances transparency and helps readers understand the study flow through various stages, such as identification, screening, eligibility, and inclusion. Recent developments have produced interactive tools that facilitate the creation of flow diagrams in line with the PRISMA 2020 guidelines, improving ease of use and compliance in reporting (Haddaway et al., 2022).

The search was limited to publications from 2012 to 2024, as the year 2012 marks a notable rise in flipped classroom research and is widely recognized as a turning point in the evolution of this pedagogical approach. In that year, the first flipped classroom-related publications appeared, with only 4 documents yet already attracting 984 citations. Over the years, there was a consistent increase in scholarly output and interest, with 147 authors contributing in 2015, and 177 in 2016, accompanied by a notable spike of 7,867 citations in 2015, largely due to highly influential works such as O'Flaherty and Phillips (2015).

Between 2017 and 2021, researchers published 1,527 articles, accumulating 19,902 citations, reflecting the rapid growth in academic engagement with flipped learning. In 2022 alone, 121 documents were published, receiving 289 citations. Altogether, from 2012 to 2022, the total publication output

exceeded 2,054 documents, clearly demonstrating a decade-long upward trend in both quantity and impact of flipped classroom research in higher education. This sustained growth justifies the selection of the 2012–2024 period for this bibliometric analysis.

3. RESULTS AND DISCUSSION

3.1. Main Information

Table 1 presents key information in the field of flipped classroom education, showing substantial annual growth and a highly visible impact. The writing collaboration pattern and the percentage of international collaboration suggest that this field likely has a high level of cooperation. Utilizing diverse keywords and interdisciplinary themes, research on scientific creativity continues to expand and enhance multiple fields, promoting innovation and fostering creativity within the global scientific community.

Table 1. Main Information of Bibliometric Data

Description	Results
Main Information About Data	
Timespan	2012-2024
Sources	639
Documents	1578
Annual Growth Rate %	53.34
Document Average Age	3.69
Average citations per doc	20.77
Document Contents	
Keywords Plus (ID)	2802
Author's Keywords (DE)	3472
AUTHORS	
Authors	4226
Authors of single-authored docs	312
Authors Collaboration	
Single-authored docs	338
Co-Authors per Doc	3.1
International co-authorships %	14.45
Document Types	
Article	1563

3.2. Publication Trends

Bibliometric analysis of flipped classroom research reveals significant trends and developments over the past decade, particularly in mathematics and higher education. The increasing number of publications indicates growing interest in this pedagogical model, with a notable peak during the COVID-19 pandemic.

The PRISMA flowchart illustrates the selection process in the bibliometric analysis. Initially, 31,133 documents were identified through a Scopus database search on September 19, 2024. Screening then excluded 1,509 irrelevant documents, such as conference proceedings, books, book chapters, reviews, errata, editorials, and notes, leaving 1,757 articles. After further screening, an additional 160 documents were excluded, resulting in a final set of 1,597 articles. Bibliometric analysis was conducted on these 1,597 documents that met the criteria. The PRISMA bibliometric flow diagram serves as an essential tool for organizing and systematically presenting research data. In the context of bibliometric analysis, this flowchart aids researchers in identifying, selecting, and examining relevant literature, providing a clear overview of the study selection process.

Table 1 provides key bibliometric data. The time span is 2012-2024, covering 639 article sources and 1,578 documents. The annual growth rate is 53.34%, with an average document age of 3.69 years. The average citations per document stand at 20.77, with no references included. There are 2,802 "Keywords Plus" (ID) and 3,472 author keywords (DE). A total of 4,226 authors contributed, with 312 single-author

documents. There are 338 single-authored documents, with an average of 3.1 authors per document. The international co-authorship rate is 14.45%, and there are 1,563 articles in total.

Figure 2. Annual Scientific Production of Flipped Classroom

This graph illustrates the number of scientific documents produced annually on the topic of "flipped classrooms" from 2012 to 2024. Initially, the publication count was very low, with fewer than 20 documents per year in 2012. However, over time, a significant increase occurred, particularly after 2017, with a sharp rise in publications, peaking in 2021 with over 220 documents. The flipped classroom model has gained significant traction in educational literature, particularly following the COVID-19 pandemic, which accelerated its adoption (Shaffi et al., 2023). Bibliometric analysis reveals a notable increase in publications related to this teaching method, especially between 2021 and 2022, underscoring its growing relevance in higher education (Pereira et al., 2024). This model enhances student engagement and learning outcomes by allowing students to interact with content before class, fostering a more interactive classroom environment (Nahar, 2024). Subsequently, a sharp decline in the number of publications occurred, especially noticeable in 2023 and 2024. This may be due to an initial surge of interest that led to study saturation, resulting in fewer new insights or innovations to publish (Chankvetadze, 2024). Some educators have faced challenges in effectively implementing the model, leading to mixed results and hesitancy about adopting it widely. (Milagros et al., 2024).

The linear regression equation on this graph shows that the R Square value of 0.8759 indicates that 87.59% of the variation in the number of documents per year can be explained by this linear regression model. An R Square value close to 1 indicates a strong correlation in the bibliometric data, suggesting that the model explains most of the variance in the bibliometric data. (Marx & Bornmann, 2014). This indicates a strong relationship between the year and the increase in publications related to flipped classrooms. The strong positive correlation (r > 0.70) suggests a significant relationship, where approximately 49% to 100% of the variance in one variable can be explained by the other variable (Denton et al., 2004).

This graph illustrates the average citations per year for flipped classroom research from 2012 to 2024. In its early emergence in 2012, the flipped classroom topic garnered significant attention, with average citations nearing 70 per year. However, in the following years, citations saw a sharp decline. In 2013, the average number of citations dropped significantly and continued to decrease until 2015, reaching below 10 citations per year. After 2015, the citation trend stabilized at a low level, with average annual citations remaining below 10 until 2024.

The decline in average citations per year suggests that newer documents may not have received the same level of attention as earlier publications, often due to shorter time frames for citation accumulation (Y. Zhang et al., 2024). This could also reflect a shift in focus or interest within the topic related to scientific

creativity. The decrease in citations for the flipped classroom topic may be attributed to critical reflections by researchers on the limitations and challenges encountered in its implementation, as well as a perceived lack of sufficient evidence to demonstrate the advantages of this method over traditional teaching methods (Keong & Jimei, 2024).
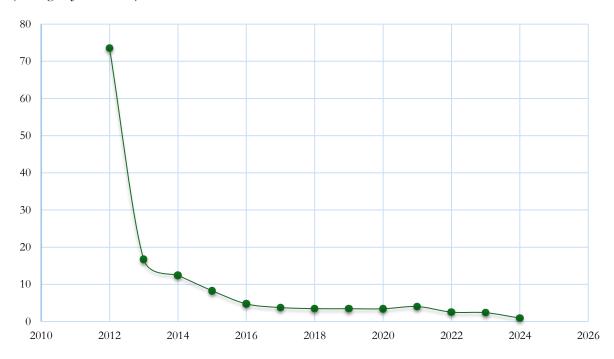

Figure 3. Average Citations Per Year in the Flipped Classroom (2012-2024)

3.3. Top Author

Productive authors provide valuable insights into the development of flipped classroom research, including productivity, collaboration patterns, and research impact. Bibliometric analysis helps uncover key trends and significant contributions that influence the development of the flipped classroom field.
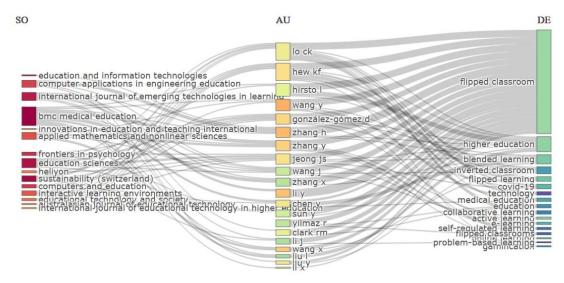

Figure 4. Thematic Development of Flipped Classroom Research using Sankey Diagram

This image uses a Sankey Diagram to illustrate the thematic development of flipped classroom research. The diagram visualizes the complex flow of information, such as the relationship between research fields and connections between authors' studies (Huang et al., 2024). This diagram maps the relationships

between scholarly journal sources (SO), authors (AU), and research themes (DE). On the left, various scholarly journals such as Education and Information Technologies, Computer Applications in Engineering Education, and BMC Medical Education are the primary sources of flipped classroom publications. In the center, key authors contributing to this research, such as Lo CK, Hew KF, Wang Y, and González-Gómez D, are shown, with each author connected to the journals where they published their articles. On the right, dominant research themes such as flipped classrooms, higher education, blended learning, and collaborative learning are displayed, reflecting the main focus of these studies. This diagram illustrates how publications from these journals, through the contributions of the authors, connect to various central themes in flipped classroom research, with the themes "flipped classroom" and "higher education" being the most dominant (Lundin et al., 2018).

Table 2. List of Top Authors and Their Impact in Flipped Classroom Research

Authors	Articles	Articles Fractionalized	h_indeks	Total Citation
Wang Y	12	5,12	7	529
Zhang H	11	5,23	5	118
Li Y	10	3,62	5	113
Wang X	10	5,75	4	43
Zhang Y	10	3,27	4	87
González-Gómez D	9	3,03	8	406
Hew KF	9	3,12	8	772
Jeong JS	9	3,03	8	406
Chen Y	8	1,95	6	452
Liu Y	7	2,86	3	55

Table 2 provides an overview of the top authors and their impact on flipped classroom research based on the number of published articles, h-index, and total citations. Wang Y is the most influential author, with 12 published articles, an h-index of 7, and a total of 529 citations, indicating the consistency and relevance of their work. In second place is Zhang H, with 11 articles, an h-index of 5, and 118 citations, followed by Li Y, with 10 articles, an h-index of 5, and 113 citations. These metrics highlight the authors' contributions and their influence in shaping the field of flipped classroom research.

Although Wang X and Zhang Y each have 10 articles, their impact is lower. Wang X has an h-index of 4 with 43 citations, while Zhang Y has a lower h-index and fewer citations compared to Li Y. Other highly influential authors include González-Gómez D, Hew KF, and Jeong JS, each with 9 articles and an h-index of 8, with Hew KF having the highest number of citations among them, totaling 772 citations. Authors such as Chen Y, with 8 articles, an h-index of 6, and 452 citations, and Liu Y, with 7 articles, an h-index of 3, and 55 citations, have also contributed to flipped classroom research, although with relatively smaller impact.

3.4. Top Sources

The most influential journals in flipped classroom research highlight their crucial role in disseminating knowledge and innovations in the field of education. This analysis includes a list of primary sources that have made significant contributions to the development of this research area.

Figure 5 shows the productivity of several key authors from 2014 to 2023. Authors such as Wang Y, Zhang H, Li Y, Gonzalez-Gomez D, and others are displayed on the vertical axis, while the years of article publication are represented on the horizontal axis. Each bubble on the chart represents the number of articles published by the author in a specific year, with the size of the bubble reflecting the number of articles published. The larger the bubble, the more articles were published.

Additionally, the color of the bubbles indicates the number of citations (Total Citations, TC) received by the articles in a given year. Darker bubbles indicate that the articles published in that year received more citations. For example, Wang Y began publishing articles in 2016 and shows an increasing number of publications up to 2023, while Gonzalez-Gomez D had several publications with a significant number of citations in 2016. Overall, this chart provides an overview of the productivity trends and scientific impact of each author during the displayed period.
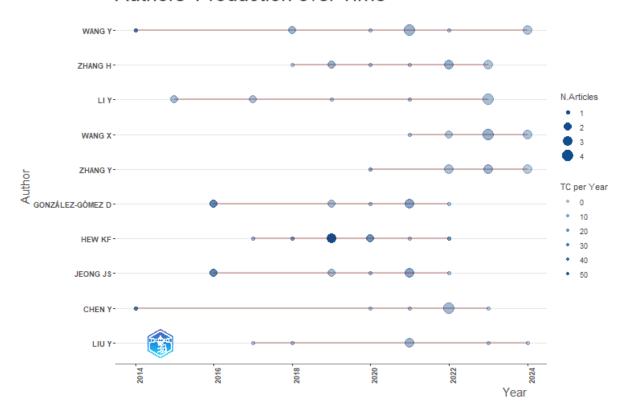
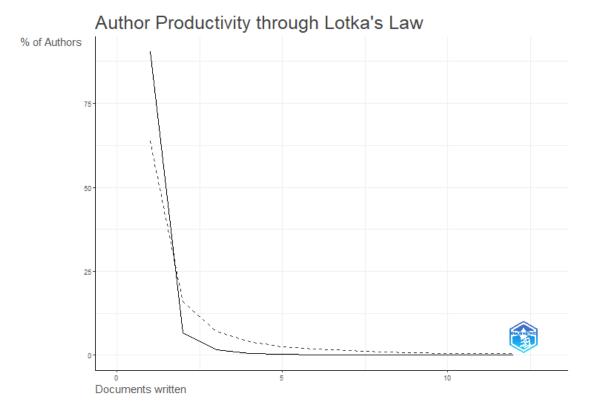**Figure 5.** Top Author Production Over Time

Figure 6. Author Productivity Through Lotka's Law

Figure 6 illustrates the distribution of author productivity based on Lotka's Law, which indicates that only a small fraction of authors are highly productive, while the majority write fewer works(Riahi et al., 2021). On the Y-axis, the percentage of authors is shown, and on the X-axis, the number of documents written by each author is displayed. The curve of the graph sharply drops at the beginning, indicating that most authors write only a few documents. After that, the curve flattens at the end, showing that only a handful of authors write more documents. This pattern reflects an uneven distribution, where scientific contributions are dominated by a small number of highly productive authors, while the majority contribute with limited works.

Table 3. Top Sources and Their Local Impact

Sources	N	Cite Score	h_index	g_index	m_index	TC	PY_start
BMC Medical Education	39	4,9	13	29	1,18	875	2014
Education Sciences	31	4,8	13	23	1,62	554	2017
Sustainability (Switzerland)	31	6,8	11	23	1,57	558	2018
International Journal Of Emerging Technologies In Learning	26	N/A	12	23	1,2	569	2015
Education And Information Technologies	21	10	8	17	0,88	318	2016
Frontiers In Psychology	20	5,3	7	9	1,4	116	2020
Computers And Education	19	27,1	18	19	1,63	2739	2014
Computer Applications In Engineering Education	18	7,2	10	17	1,42	317	2018
PRIMUS	18	1,6	9	18	0,9	331	2015
Applied Mathematics And Nonlinear Sciences	17	2,9	1	1	1	5	2024

Table 3 displays the key sources and their local impact across various fields of education and science. The "Sources" column lists the names of journals or scientific publications. The "N" column indicates the number of documents or articles published by each source. "Cite Score" is a value that reflects the average impact per article published by the source. Other indicators include the "h_index," which measures the number of publications and the citations they receive, demonstrating the productivity of researchers and the citation impact of their works (Mondal et al., 2023), The g-index enhances the h-index by giving more weight to highly cited articles. It is defined as the highest number of g such that the top g articles, taken together, have at least g^2 citations (Borgohain et al., 2023), and m-index, which measures the productivity and citation impact of an author or journal over a specific period of time (Borgohain et al., 2023).
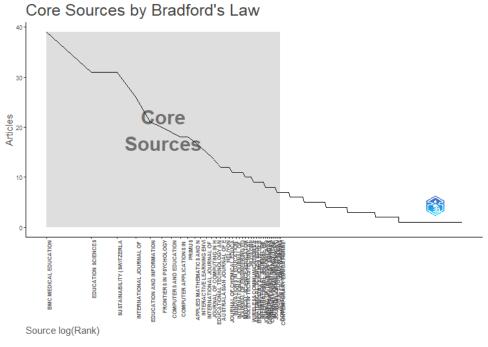

Figure 7. Core Sources Through Bradford's Law

Several prominent publications in this table include BMC Medical Education, with 39 documents, a CiteScore of 4.9, and a total of 875 citations since its inception in 2014. Computers and Education stands out with 19 documents, a CiteScore of 27.1, and an exceptionally high total citation count of 2,739 since

2014. Additionally, Education Sciences and Sustainability (Switzerland) exhibit relatively high CiteScores of 4.8 and 6.8, respectively, with significant numbers of documents and citations.

Figure 7 illustrates the distribution of core sources based on Bradford's Law, which indicates that a small number of journals contribute the majority of scientific articles (Summers, 2014). The vertical axis shows the number of articles published by each journal, while the horizontal axis represents the logarithmic ranking of journals based on the number of articles published. The shaded area highlights the core sources that contribute most significantly to scientific publications. BMC Medical Education ranks at the top with approximately 39 articles, followed by Education Sciences and Sustainability (Switzerland). After these core sources, the contribution of articles from other journals decreases significantly. Bradford's Law emphasizes that most articles are produced by a few leading journals, while other journals contribute much less(Biradar & Kumbar, 2020).
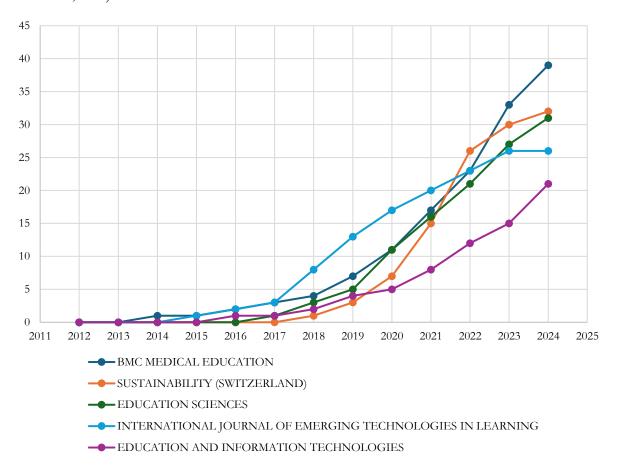

Figure 8. Top Sources Publication Growth

Figure 8 shows the growth of publications from the top 5 sources over the period 2012 to 2024. These sources are BMC Medical Education, Sustainability (Switzerland), Education Sciences, Education and Information Technologies International Journal of Emerging Technologies in Learning, and Education and International Journal of Emerging Technologies in Learning.

The chart shows that all sources have experienced an increase in the number of publications over time. However, some sources have demonstrated more significant growth than others. For example, publications in BMC Medical Education and Sustainability (Switzerland) have rapidly increased in recent years. By 2024, BMC Medical Education has published over 40 articles, while Sustainability (Switzerland) has published more than 30 articles.

The publication growth in Education Sciences, International Journal of Emerging Technologies in Learning, and Education and Information Technologies has been slower. However, all of these sources have shown steady growth over the period. By 2024, Education Sciences has published more than 25

articles, International Journal of Emerging Technologies in Learning has published over 20 articles, and Education and Information Technologies has also published more than 20 articles.

3.5. Most Influential Literature

The collection of literature most frequently cited in the field of flipped classroom learning from 2012 to 2024 serves as an important references for researchers and education practitioners. Table 4 presents articles with significant influence in this area, based on total citations and citations per year.

Table 4. Most Highly Cited Flipped Classroom Paper from 2012 to 2024

Rank	Total Citation	TC per Year	Author(s)	Year	DOI	Source
1	1344	134.4	O'Flaherty J	2015	10.1016/j.iheduc.2015.02.002	Internet Higher Educ
2	956	73.53	Strayer JF	2012	10.1007/s10984-012-9108-4	Learn Environ Res
3	833	75.72	Mclaughlin JE	2014	10.1097/ACM.0000000000000086	Acad Med
4	609	50.75	Davies RS	2013	10.1007/s11423-013-9305-6	Educ Technol Res Dev
5	582	58.2	Gilboy MB	2015	10.1016/j.jneb.2014.08.008	J Nutr Educ Behav
6	577	52.45	Kim MK	2014	10.1016/j.iheduc.2014.04.003	Internet Higher Educ
7	507	50.7	Jensen JL	2015	10.1187/cbe.14-08-0129	Cbe Life Sci Educ
8	417	104.25	Iglesias-Pradas S	2021	10.1016/j.chb.2021.106713	Comput Hum Behav
9	411	37.36	Chen Y	2014	10.1016/j.compedu.2014.07.004	Comput Educ
10	336	28	Enfield J	2013	10.1007/s11528-013-0698-1	TechTrends

Table 4 lists the top 10 most cited papers on flipped classrooms from 2012 to 2024. The table includes rankings, total citations, citations per year, authors, publication year, DOI, and sources. The most cited article is "O'Flaherty, J. (2015). Flipped Learning in Higher Education: A Review of the Research. Internet and Higher Education, 25, 1-8." This article has been cited 1,344 times, with an average of 134.4 citations per year. It was published in Internet and Higher Education, this is due to the fact that flipped learning has gained significant attention in the field of education, especially with the rise of technology-based teaching methods. The relevance of this topic for educators seeking to innovate in their teaching methods makes this article frequently cited (Baig & Yadegaridehkordi, 2023).

Other articles on the list have also been widely cited, with many having over 500 citations. These articles are published in various journals, including the Journal of Nutrition Education and Behavior, Academic Medicine, Computers & Education, and Higher Education.

3.6. Top Countries and Affiliations

Table 5 displays data on the countries with the highest number of documents and scientific citations. The United States leads with the highest number of documents, totaling 583, followed by China with 565 documents, and Spain with 265 documents. The United States also ranks first in total citations, reaching 6541, with an average of 32.2 citations per article, making it the country with the largest contribution and scientific impact in the field. This is due to the United States having a large number of higher education institutions and research centers, including renowned universities (such as Harvard, MIT, and Stanford) that are actively engaged in producing high-quality research(Compagnucci & Spigarelli, 2020). This leads to a higher volume of publications, including in the field of flipped learning and technology-based teaching methods(Lundin et al., 2018).

According to Table 5, China ranks second with a total of 4,142 citations, although its average citations per article is only 15.7. Spain ranks third with a total of 2,882 citations and an average of 25.7 citations per article.

Other countries with significant contributions include Australia with 151 documents and an average of 19.8 citations per article, as well as Indonesia and Malaysia, each contributing 94 documents but with lower average citations per article, at 8.5 and 10.5, respectively. The United Kingdom, Turkey, Germany, and Iran are also listed in the table, with the UK contributing 93 documents and an average of 15.2 citations per article, while Turkey produced 90 documents with an average of 19.2 citations per article. Germany and

Iran occupy the last two positions in the table, with 85 and 78 documents, respectively, and average citations per article of 15.6 and 17.8.

Table 5. Countries with the HighestnNumbernof Documents and Citations

Country	Frequency	TC	Average Article Citations
USA	583	6541	32.2
China	565	4142	15.7
Spain	265	2882	25.7
Australia	151	948	19.8
Indonesia	94	272	8.5
Malaysia	94	325	10.5
Uk	93	440	15.2
Turkey	90	866	19.2
Germany	85	546	15.6
Iran	78	499	17.8

From this data, it is clear that the United States not only leads in the number of documents produced but also has a significant scientific impact, as reflected in the average citations per article(Teplitskiy et al., 2022). While China has a similar number of documents to the United States, its scientific impact is lower when viewed from the average citation perspective.
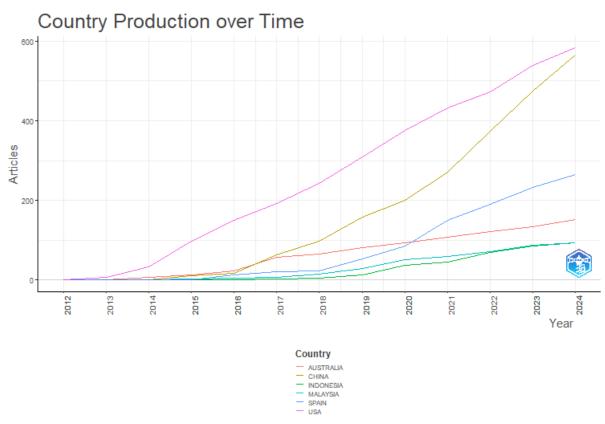

Figure 9. Document Growth of Flipped Classroom by Country

Figure 9 shows the development of the number of scientific articles produced by several countries from 2012 to 2024. The United States, which had the highest article production, saw a significant increase starting in 2016 and continued to grow, reaching over 500 articles in 2024. China also showed rapid growth, particularly after 2016, and by 2024 had produced around 400 articles, making it the second-highest country in terms of article production after the United States.

Spain ranks third with more moderate growth, reaching around 200 articles by 2024. Australia also experienced steady growth, reaching nearly 150 articles during the same period. Meanwhile, Indonesia and Malaysia began showing more noticeable increases in article numbers since 2019, with Indonesia slightly

surpassing Malaysia at just over 100 articles by 2024. Overall, this graph reflects the dominance of the United States and China in scientific article production, while other countries such as Spain, Australia, Indonesia, and Malaysia also experienced positive growth, albeit on a smaller scale.
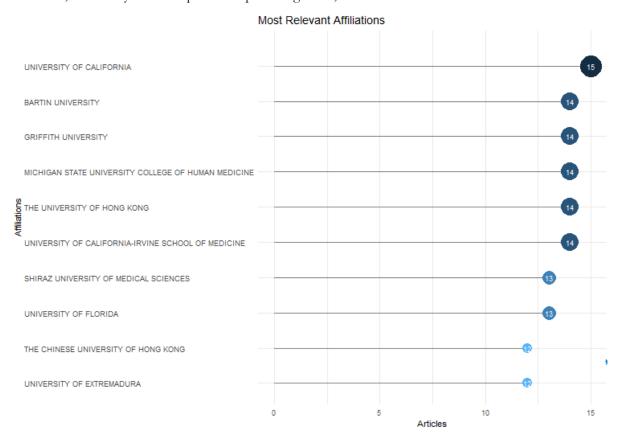

Figure 10. Top Affiliations

Figure 10 displays the most relevant affiliations from various universities or institutions that contributed to the number of articles produced on a specific research topic. The horizontal axis represents the number of articles published, while the vertical axis lists the names of universities or institutional affiliations (Yu et al., 2023). The University of California tops the chart with 15 articles, making it the largest contributor. Several other universities, such as Bartin University, Griffith University, Michigan State University College of Human Medicine, The University of Hong Kong, University of California-Irvine School of Medicine, and Shiraz University of Medical Sciences, each contributed 14 articles, indicating their active involvement in this research area. The University of Florida and The Chinese University of Hong Kong follow with 13 articles each. On the other hand, the University of Extremadura ranks at the bottom with just one article. This graph reflects the distribution of research contributions from universities across different countries, with the University of California being the leading institution.

3.7. Keywords Tren

Figure 11 illustrates the most relevant keywords in a collection of articles or research along with their frequency of occurrence. The horizontal axis represents the number of occurrences of these keywords, while the vertical axis lists the keywords considered most relevant. This type of visualization helps identify key themes and concepts in the research, providing insight into the areas that are most frequently discussed or studied in the field.
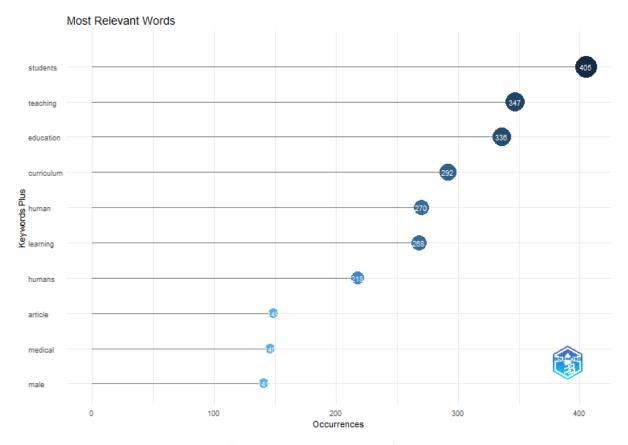
Figure 11. Most Frequent Words

According to Figure 11, the word "students" has the highest frequency with 405 occurrences, indicating its dominant presence in the analyzed research. Other frequently appearing words such as "teaching" (347), "education" (338), "curriculum" (292), "learning" (288), and "human" (270) also suggest that the topics discussed are largely related to these themes. On the other hand, words like "humans" and "article" have lower frequencies, below 250 occurrences, but they remain relevant, reflecting the technical or analytical aspects involved in the research.
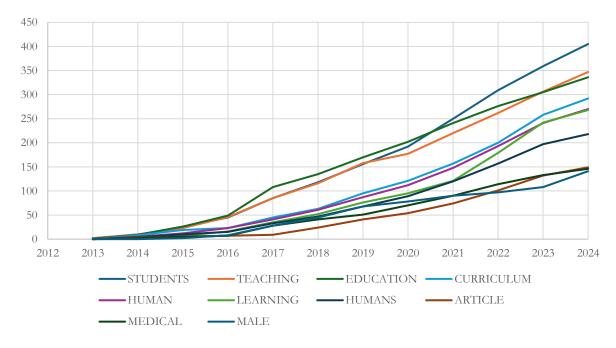

Figure 12. Words' Frequency Over Time

Figure 12 shows the change in frequency of several key terms from 2012 to 2024. The analyzed terms include topics related to education, such as "students," "teaching," "education," and "learning," as well as other terms like "human," "medical," and "article." Since 2016, there has been a significant increase in the use of education-related terms, with "students" emerging as the most frequently used term by 2024, surpassing 400 occurrences. "Teaching" and "education" also showed rapid growth, reflecting the increasing interest in research or topics related to education. Terms like "curriculum" and "learning" also saw growth, though with slightly lower frequencies. On the other hand, terms like "human," "medical," and "article" exhibited slower growth, yet remain relevant, indicating a consistent focus on these topics.

3.8. Analysis of Knowledge Structure

The analysis of knowledge structure aims to understand the relationships between topics and the development of research over time. This analysis includes identifying key themes (such as student engagement or active learning), as well as patterns of collaboration among researchers through bibliometric analysis. Additionally, mapping the knowledge structure helps visualize how flipped classroom research is connected to other fields(Levidze, 2024). By examining these interconnections, researchers can gain insights into the evolution of the flipped classroom model and its integration with other educational strategies and disciplines. This kind of analysis can also reveal emerging trends, collaborative networks, and potential gaps in the research, guiding future studies in the field.
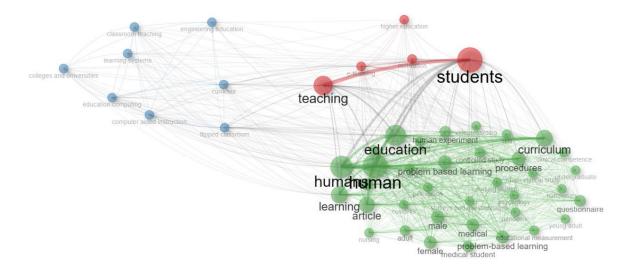

Figure 13. Co-Occurrence Network

Figure 13 illustrates the relationships between keywords in academic publications based on bibliometric analysis. Larger nodes, such as "students" and "teaching" (colored in red), indicate that these keywords appear frequently in the research, signaling their central role in the field. Keywords like "education," "learning," and "humans" (colored green) also appear often, albeit with slightly lower frequencies. The connecting lines between nodes represent how frequently the keywords co-occur, with thicker lines indicating stronger relationships, such as between "students" and "teaching." The color of the nodes reflects different thematic clusters, where the red cluster focuses on students and teaching, the green cluster covers broader topics like education and learning, and there is a blue cluster in the top left corner related to specific topics like technology-based teaching methods (Dong et al., 2023). This visualization provides a comprehensive overview of the key themes in flipped classroom research and their interconnections, helping to identify dominant areas of study and emerging trends.
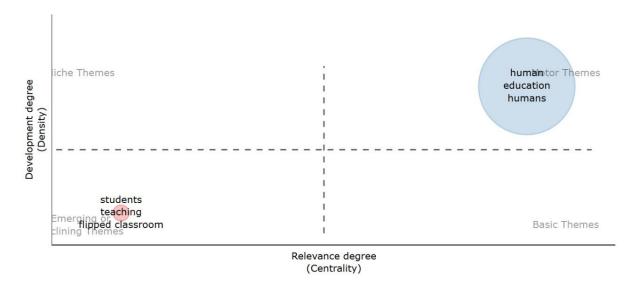
Figure 14. Thematic Map

Figure 14 illustrates the relationship between the development (density) and relevance (centrality) of various research themes (Bagdi et al., 2023). In the upper-right quadrant, representing Motor Themes, there are themes such as "humans," "education," and "human," which exhibit both high relevance and development. This indicates that these topics are the central and established focus areas in research. Conversely, in the lower-left quadrant, representing Emerging or Declining Themes, themes like "students," "teaching," and "flipped classroom" have lower relevance and development, suggesting that these themes might still be in the early stages of development or are experiencing a decline in popularity. No themes are found in the Basic Themes or Niche Themes quadrants on this map, indicating that these areas either are not prominent in the current literature or are yet to emerge as significant themes in the field. This map provides a clear visual representation of the relative importance and maturity of various research themes in flipped classroom studies.
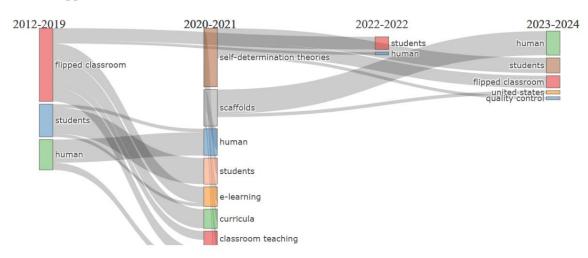

Figure 15. Thematic Evolution

Figure 15 illustrates the evolution of educational themes from 2012 to 2024. Between 2012 and 2019, the flipped classroom emerged as the central focus, closely linked to the roles of students and humans. During this period, the flipped classroom became an innovative teaching method that placed students and human interaction at the core of the learning process (Sun et al., 2023).

Entering the period from 2020 to 2021, a significant shift occurred with the emergence of self-determination theories, emphasizing the importance of intrinsic motivation in education (Ryan, 2020). Additionally, scaffolding or gradual assistance in the learning process became a key focus, followed by themes such as e-learning, curricula, and classroom teaching. The focus during this period reflects a

methodological shift in education, including the application of motivational theories and the rise of online learning (Dominguez & Svihla, 2023).

In the period from 2022 to 2022, the themes of students and humans once again came to the forefront, indicating that the focus on students and human aspects in education continues to be relevant(C Hattie, 2009). Although there were no significant changes compared to the previous period, these themes remain central in the educational context.

In the period from 2023 to 2024, the themes of "human" and "students" remain dominant, alongside the re-emergence of the "flipped classroom" theme, indicating that this method continues to be relevant in contemporary educational contexts. Additionally, new themes such as "United States" and "quality control" have emerged, reflecting a growing focus on education quality control and possibly on specific regions, such as the United States.
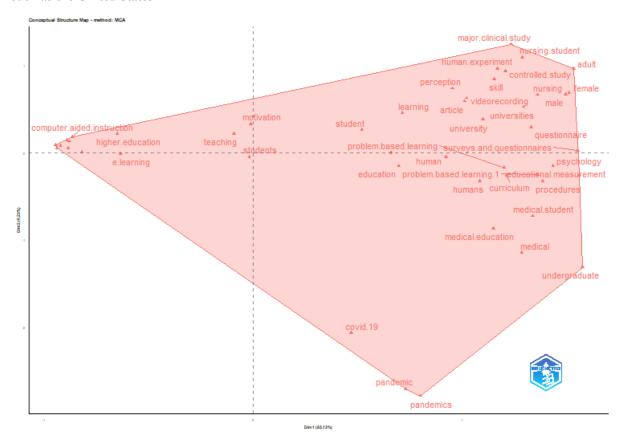

Figure 16. Factorial Analysis Using MCA

Figure 16 visualizes the relationships among various themes in education through Multiple Correspondence Analysis (MCA)(Husson et al., 2015). This diagram illustrates the distribution of keywords based on thematic proximity, represented in a two-dimensional space. In the upper left section, themes such as computer-aided instruction, higher education, e-learning, teaching, and motivation cluster together, indicating a strong association with technology-based education and online learning(Tonbuloglu, 2023). In the upper right section, a cluster encompasses the major clinical study, nursing, controlled study, and medical education, focusing on clinical research and education within the medical field.

Meanwhile, in the lower right section, themes such as undergraduate, medical student, psychology, and problem-based learning appear, indicating a connection with medical education and problem-based learning approaches. In the lower section, pandemic-related themes such as COVID-19 and pandemics emerge, highlighting the impact of the pandemic on global education. The positioning of keywords in this two-dimensional space suggests that themes closer to one another frequently co-occur within the same context, such as problem-based learning, which is closely associated with curriculum and educational measurement(Smith et al., 2022).
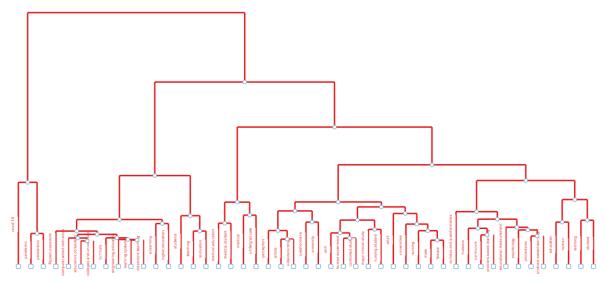
Figure 17. Thematic Dendrogram

Figure 17 provides a visual representation of the results from a hierarchical cluster analysis. A dendrogram is used to illustrate the relationships among data groups, with clustering progressively performed based on the level of similarity between objects or themes(Ju et al., 2007). Each branch on the dendrogram connects similar objects, where longer branches indicate objects or groups of objects that are less similar, while shorter branches indicate objects that are more similar to each other(Bapteste et al., 2013).

In this dendrogram, we observe that the theme COVID-19 is situated on a separate branch on the left, indicating that this theme differs significantly from other theme groups. Below it, themes such as pandemic and higher education are clustered together, suggesting a close relationship, possibly linked to how the COVID-19 pandemic has impacted higher education. Further along, we see more complex and larger branches in the middle to the right of the dendrogram, where themes like e-learning, motivation, problem-based learning, and medical education are grouped within smaller branches. This indicates that these topics frequently co-occur or are closely related within studies or contexts, such as in online learning, student motivation, or problem-based approaches in medical education.

Moving further down the dendrogram, the clustering becomes increasingly specific, with each theme divided into smaller, more similar subgroups. This process illustrates how relationships among themes are constructed from broader clusters to more specific ones, based on their level of similarity(Ifaei et al., 2023).
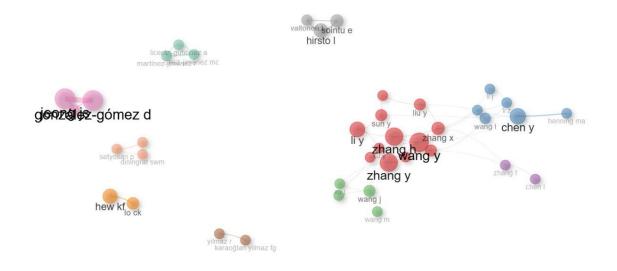

Figure 18. Collaboration Network

Figure 18 displays a visualization of the collaboration network. Each node represents an individual, likely a researcher, identified by their name within the node. The size of each bubble appears to reflect the importance or centrality of the individual within the network, possibly related to the number of collaborations or contributions they have made (Fouad & Rego, 2024). There are several groups or clusters indicating collaboration within smaller, more specific teams. For example:

- The red cluster centers around several individuals with the surname "Zhang," indicating a closely-knit group of collaborators, including "Zhang Y," "Wang Y," and "Li Y." This suggests a strong collaboration network among researchers who may share the same field or institution (D. Zhang et al., 2024).
- The blue cluster is centered around "Chen Y" and connects with several other collaborators, forming another close-knit collaborative group.
- Additionally, there are smaller clusters (such as pink, green, and orange clusters) representing groups of researchers or research fields with fewer participants.

The connecting lines between nodes represent collaborations among researchers (D. Zhang et al., 2024). The line thickness likely indicates the strength or frequency of collaboration, whereas thicker lines may signify more frequent or closer working relationships. Some nodes within the larger clusters, such as the red and blue clusters, are highly interconnected, indicating an established collaboration network, while others have fewer connections. The colors of the nodes and clusters suggest groups of individuals who frequently collaborate or may come from the same research field or institution. There are also a few isolated pairs of nodes, such as those in the orange cluster in the lower left, which likely represent limited collaboration between two or three individuals without broader network involvement (Luo et al., 2023).
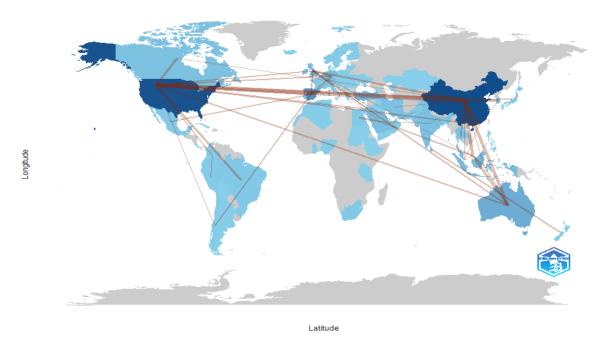

Figure 19. Country Collaboration Map

The image displays a map of international collaboration, illustrating research partnerships across countries (Leydesdorff et al, 2013). Dark blue countries, such as the United States and China, appear as primary hubs within the global collaboration network. Other countries in light blue, including several European nations, Australia, and parts of Southeast Asia, also demonstrate significant involvement in collaboration, though with slightly lower intensity. The connecting lines between countries represent direct collaborations, where thicker lines may indicate stronger or more frequent partnerships, while thinner lines reflect less frequent interactions.

The United States and China appear to function as two primary nodes in this network, connecting with various countries worldwide, including Europe, Australia, and several countries in Asia and South America. Countries such as Australia and Germany also play important roles as collaborative hubs within

this network. Most collaborations are concentrated among countries in North America, Europe, Asia, and Australia, with more limited involvement from countries in Africa and South America, though they remain connected to the global network.

4. CONCLUSION AND IMPLICATIONS

Based on Table 6, it can be concluded that this research field has experienced significant growth, with an annual growth rate of 53.34%, resulting in a total of 1,578 documents. A total of 4,226 authors have contributed to this field, with the most prolific author being Wang Y. This research is published across 639 different sources, with the most productive sources being related to students, teaching, education, graduates, teachers, and training.

Table 6. Summary of the Findings

Parameters	Information
Number of documents	1578
Annual growth rate (%)	53.34
Number of authors	4226
Top author	Wang Y (n = 4)
Number of sources	639
The most productive source	BMC Medical Education
Top-cited article (DOI)	10.1016/j.iheduc.2015.02.002
The country with the most publication	USA (n = 583)
University with the highest number of documents	University of California (n = 15)
The most favorite keywords	Students, teaching, education, curriculum, human, learning, humans, article, medical, dan male.
Emerging research directions	Flipped classroom, use of technology and digital tools, student engagement and Motivation

The most cited article has the DOI 10.1016/j.jheduc.2015.02.002. Geographically, the United States is the country with the highest number of publications, totaling 583 documents, with the University of California contributing 15 documents. Popular keywords used in this research include four main topics that resonate in the studies: students, teaching, education, curriculum, and technology. This indicates a focus on research related to practices and methodologies.

This study has several limitations. First, the data is solely sourced from Scopus, which limits the scope of the research and may introduce bias since it does not include other databases such as Web of Science or Google Scholar. To address this, future research is recommended to expand the data sources. Second, the approach that relies only on bibliometric analysis does not provide an in-depth understanding of the direct experiences of students and instructors in the implementation of flipped classrooms. Combining this method with interviews or surveys could provide richer insights.

Additionally, this study does not sufficiently consider the cultural or regional context that affects the effectiveness of the flipped classroom, such as technological readiness and educational culture. Comparative studies across regions could provide more relevant recommendations. Finally, bibliometric analysis tends to overlook the direct impact of articles on educational practice. A qualitative analysis of key articles would help complement the understanding of the benefits of the flipped classroom. By addressing these limitations, future research could offer more comprehensive recommendations for educators and policymakers in the field of technology-based education.

Based on the findings, several practical implications can be drawn for key stakeholders, including researchers, educators, and policymakers, to enhance the development and implementation of flipped classroom practices.

- For researchers, the bibliometric mapping identifies influential works, key authors, and emerging themes that can serve as a basis for future studies. Researchers are encouraged to explore underrepresented areas such as flipped classrooms in developing countries, cross-disciplinary implementation, and long-term learning outcomes.

- For educators, this study highlights the importance of implementing flipped classrooms with careful attention to content design and student engagement strategies. Educators can utilize technology-enhanced tools, integrate collaborative activities, and tailor pre-class materials to better support diverse learning needs and promote autonomy.
- For policymakers, the study provides data-driven insights to support curriculum reform and teacher training programs. The growing trend of flipped classroom research suggests a shift toward more student-centered pedagogies. Policymakers should consider funding initiatives that support digital infrastructure and capacity-building to sustain effective flipped learning environments, especially in higher education institutions.

These implications emphasize the real-world utility of bibliometric evidence in shaping more informed, strategic decisions across the educational landscape.

REFERENCES

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, *126*, 334–345. https://doi.org/10.1016/j.compedu.2018.07.021

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, *1*(1), 377–386. https://doi.org/10.1162/qss_a_00019

Bagdi, T., Ghosh, S., Sarkar, A., Hazra, A. K., Balachandran, S., & Chaudhury, S. (2023). Evaluation of research progress and trends on gender and renewable energy: A bibliometric analysis. *Journal of Cleaner Production*, *423*(138654). http://doi.org/10.1016/j.jclepro.2023.138654

Baig, M. I., & Yadegaridehkordi, E. (2023). Flipped classroom in higher education: a systematic literature review and research challenges. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-023-00430-5

Bapteste, E., van Iersel, L., Janke, A., Kelchner, S., Kelk, S., McInerney, J. O., Morrison, D. A., Nakhleh, L., Steel, M., Stougie, L., & Whitfield, J. (2013). Networks: Expanding evolutionary thinking. *Trends in Genetics, 29*(8), 439–441. https://doi.org/10.1016/j.tig.2013.05.007

Biradar, N., & Kumbar, P. (2020). A Comparative Study: Application of Bradford's Law of Scattering to the Epidemiology Literature of India and Japan. *Research Journal of Library and Information Science*, *4*(1), 7–16.

Bishop, J. L., & Verleger, M. A. (2013). The Flipped Classroom: A Survey of the Research. *120th American Society for Engineering Education Annual Conference and Exposition, 30*, 1-18.

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education, 151*, 103819. https://doi.org/10.1016/j.compedu.2020.103819

Borgohain, D. J., Lund, B., & Verma, M. K. A mathematical analysis of the h-index and study of its correlation with some improved metrics: A conceptual approach. *Journal of Information Science*. https://doi.org/10.1177/01655515231184832

Bornmann, L., Haunschild, R., & Mutz, R. (2021). Growth rates of modern science: a latent piecewise growth curve approach to model publication numbers from established and new literature databases. *Humanities and Social Sciences Communications*, *8*(1). https://doi.org/10.1057/s41599-021-00903-w

Chankvetadze, A. (2024). Flipped classroom: rising motivation of new generation or challengeable way of studying on higher education level (case study in Georgia). *Proceedings of the International Conference on Innovative Research in Education*, *1*(1), 21–31. https://doi.org/10.33422/ireconf.v1i1.442

Chasokela, D. (2025). Role of Technology Integration in the Development of 21st-Century Skills STEM University in Zimbabwe. *Journal of Research in Education and Pedagogy, 2*(1), 124-135. https://doi.org/10.70232/jrep.v2i1.36

Compagnucci, L., & Spigarelli, F. (2020). The Third Mission of the university: A systematic literature review on potentials and constraints. *Technological Forecasting and Social Change*, *161*. https://doi.org/10.1016/j.techfore.2020.120284

Davies, R. S., Dean, D. L., & Ball, N. (2013). Flipping the Classroom and Instructional Technology Integration in a College-Level Information Systems Spreadsheet Course. *Education Technology Research and Development, 61*, 563-580. http://dx.doi.org/10.1007/s11423-013-9305-6

Del Arco, I. (2022). Bibliometric analysis of the flipped classroom pedagogical model: Trends and strategic lines of study. *Frontiers in Education, 7*, 1022295. https://doi.org/10.3389/feduc.2022.1022295

Denton, G. D., Durning, S. J., & Hemmer, P. A. (2004). Letter to the editor: A Call for Use of Confidence Intervals With Correlation Coefficients. *Teaching and Learning in Medicine, 16(*1), 111–112. https://doi.org/10.1207/s15328015tlm1601_20

Din, A. G. bin M., Din, O. bin M., Tohyala, I., Taher, R., Zabidin, M. A. R. bin, & Hamed, P. K. (2024). Modern Technology of the Education: A Bibliometric Analysis. *International Journal of Academic Research in Business and Social Sciences, 14*(1), 1735–1748. http://dx.doi.org/10.6007/IJARBSS/v14-i1/20596

Dominguez, S., & Svihla, V. (2023). A review of teacher implemented scaffolding in K-12. *Social Sciences and Humanities Open*, *8*(1). https://doi.org/10.1016/j.ssaho.2023.100613

Dong, M., Li, F., & Chang, H. (2023). Trends and hotspots in critical thinking research over the past two decades: Insights from a bibliometric analysis. *Heliyon*, *9*(6). https://doi.org/10.1016/j.heliyon.2023.e16934

Dosi, G., & Nelson, R. (2013). The Evolution of Technologies: An Assessment of the State-of-the-Art. . *Eurasian Business Review*, *3*, 3–46.

Fouad, H., & Rego, N. (2024). Can social network analysis contribute to supply chain management? A systematic literature review and bibliometric analysis. *Heliyon*, *10*(5). https://doi.org/10.1016/j.heliyon.2024.e26598

Gilboy, M. B., Heinerichs, S., & Pazzaglia, G. (2015). Enhancing student engagement using the flipped classroom. *Journal of Nutrition Education and Behavior*, *47*(1), 109–114. https://doi.org/10.1016/j.jneb.2014.08.008

Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Systematic Reviews*, *18*(2). https://doi.org/10.1002/cl2.1230

Handayani, D. (2025). Tracing Virtual Reality Research: A 2009–2024 Bibliometric Analysis. *Journal of Technology-Assisted Learning, 1*(1), 1-22. https://doi.org/10.70232/jtal.v1i1.1

Hattie, J. A. C. (2009). Visible Learning: A Synthesis of over 800 Meta-Analyses Relating to Achievement. Routledge. https://doi.org/10.4324/9780203887332

Huang, J., Kim, F. C., & Johanes, M. (2024). Parametric Sankey: Interactive Mapping of Complex Material Flows for Urban and Architectural Design. In *Computational Design and Robotic Fabrication: Vol. Part F2072* (pp. 248–259). Springer. https://doi.org/10.1007/978-981-99-8405-3_21

Husson, F., Ouest, A., Husson, F., & Josse, J. (2015). *1 Multiple Correspondence Analysis*. https://www.researchgate.net/publication/266856006

Ifaei, P., Nazari-Heris, M., Tayerani Charmchi, A. S., Asadi, S., & Yoo, C. (2023). Sustainable energies and machine learning: An organized review of recent applications and challenges. *Energy, 266*, 126432. https://doi.org/10.1016/j.energy.2022.126432

Ju, Z., Wells, M. C., & Walter, R. B. (2007). DNA microarray technology in toxicogenomics of aquatic models: methods and applications. Comparative biochemistry and physiology. *Toxicology & Pharmacology : CBP, 145*(1), 5–14. https://doi.org/10.1016/j.cbpc.2006.04.017

Keong, T. C., & Jimei, G. (2024). Analyzing Flipped Classroom Themes Trends in Computer Science Education (2007–2023) Using CiteSpace. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *46*(1), 15–27. https://doi.org/10.37934/araset.46.1.1527

Kim, M. K., Kim, S. M., Khera, O., & Getman, J. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. *The Internet and Higher Education, 22*, 37-50. https://doi.org/10.1016/j.iheduc.2014.04.003

Levidze, M. (2024). Mapping the research landscape: A bibliometric analysis of e-learning during the COVID-19 pandemic. *Heliyon*, *10*(13). https://doi.org/10.1016/j.heliyon.2024.e33875

Leydesdorff, L., Wagner, C. S., Park, H.-W., & Adams, J. (2013). Colaboración internacional en ciencia: mapa global y red. *Profesional De La información, 22*(1), 87–94. https://doi.org/10.3145/epi.2013.ene.12

Lundin, M., Bergviken Rensfeldt, A., Hillman, T., Lantz-Andersson, A., & Peterson, L. (2018). Higher education dominance and siloed knowledge: a systematic review of flipped classroom research. *International Journal of Educational Technology in Higher Education*, *15*(1). https://doi.org/10.1186/s41239-018-0101-6

Luo, Y. X., Zhu, Y. H., & Yao, X. Q. (2023). Knowledge mapping of exercise and physical activity research in older adults: Hotspots, bursts, and trends of the last decade. *Heliyon*, *9*(12). https://doi.org/10.1016/j.heliyon.2023.e23181

Marx, W., & Bornmann, L. (2014). On the problems of dealing with bibliometric data. *Journal of the Association for Information Science and Technology, 65*(4), 866-867. https://doi.org/10.1002/asi.23059

McLaughlin, Roth, Glatt, Gharkholonarehe, Davidson, Griffin, Esserman, & Mumper. (2014). The Flipped Classroom A Course Redesign to Foster Learning and Engagement in a Health Professions School. *Academic Medicine*, *89*(2), 236–243. https://doi.org/10.1097/ACM.0000000000000086

Melati, M., & Hadinugrahaningsih, T. (2024). The Effect of Numbered Head Together (NHT) in a Flipped Classroom Environment on Students' Self-Efficacy and Achievement on Colloid Topics. *Journal of Research in Education and Pedagogy, 1*(1), 24-29. https://doi.org/10.70232/c99bex94

Meng, J., Lou, W., & He, J. (2022). Quantifying Individual Research's Distance from the Trends based on Dynamic Topic Modeling. *Proceedings of the Association for Information Science and Technology, 59*(1), 762-763. https://doi.org/10.1002/pra2.718

Milagros, E., Carrillo-Yalán., Vargas-Trujillo, Daysi, G.-Cuéllar., Emma, Cortez-Llanos., Y., & Villarreal-Montenegro. (2024). Flipped Classroom Based on Blum's Modeling and its Impact on Autonomous Learning Experienced by Mathematics Students from a University in Lima, Peru. *Academic Journal of Interdisciplinary Studies, 13*(3), 227. https://doi.org/10.36941/ajis-2024-0077

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2010). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery*, *8*(5), 336–341. https://doi.org/10.1016/j.ijsu.2010.02.007

Mondal, H., Deepak, K. K., Gupta, M., & Kumar, R. (2023). The h-Index: Understanding its predictors, significance, and criticism. *Journal of Family Medicine and Primary Care, 12*(11), 2531. https://doi.org/10.4103/jfmpc.jfmpc_1613_23

Mongeon, P., & Paul-Hus, A. (2016). The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. Scientometrics, 106, 213-228. https://doi.org/10.1007/s11192-015-1765-5

Nahar, J. (2024). *British Journal of Teacher Education and Pedagogy Assessing the Efficacy and Acceptance of Flipped Classroom Method in Tertiary-Level English Vocabulary Learning: A Thematic Data Analysis in Post-Pandemic Bangladesh*. https://doi.org/10.32996/bjtep

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education, 25*, 85-95. https://doi.org/10.1016/j.iheduc.2015.02.002

Pereira de Oliveira Almeida, E., Souza Salvador, A., Candeia de Melo, A., & Santos Oliveira, J. L. (2024). Flipped classroom: bibliometric analysis and contributions of teaching and learning in higher education between 2019 and 2023. *Cadernos De Educação Tecnologia E Sociedade, 17*(1), 264–274. https://doi.org/10.14571/brajets.v17.n1.264-274

Prahani, B. K., Rizki, I. A., Suprapto, N., Irwanto, I., & Kurtuluş, M. A. (2024). Mapping research on scientific creativity: A bibliometric review of the literature in the last 20 years. *Thinking Skills and Creativity*, *52*. https://doi.org/10.1016/j.tsc.2024.101495

Rakhmalinda, F. (2024). Trends in Flipped Classroom of Higher Education: Bibliometric Analysis (2012–2022). *Journal of Research in Mathematics, Science, and Technology Education, 1*(1), 19–34. https://doi.org/10.70232/bd895m13

Rakhmalinda, F. (2024). Trends in flipped classroom of higher education: Bibliometric analysis (2012-2022). *Journal of Research in Mathematics*, 1(1). https://spm-online.com/jrmste

Riahi, Y., Saikouk, T., Gunasekaran, A., & Badraoui, I. (2021). Artificial intelligence applications in supply chain: A descriptive bibliometric analysis and future research directions. Expert Systems With Applications, 173, 114702. https://doi.org/10.1016/j.eswa.2021.114702

Selvan, P. T., & Kalaiyarasan, G. (2024). STEM Knowledge Awareness among Higher Secondary School Students. *Journal of Education for Sustainable Development Studies, 1*(2), 89-96. https://doi.org/10.70232/jesds.v1i2.14

Shaffi, S., Tarek, S., & Watson, A. (2023). Enhancing Business Education through Flipped Classroom Pedagogies: The Systematic Review. *Creative Education*, *14*(7), 1481–1495. https://doi.org/10.4236/ce.2023.147094

Smith, K., Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., Mansfield, J., Ellerton, P., & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM Education: Using Expert Wisdom and Research to Frame Educational Practice. *Education Sciences*, *12*(10). https://doi.org/10.3390/educsci12100728

Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*, *15*, 171–193. https://doi.org/10.1007/s10984-012-9108-4

Sulastri, S. K. (2025). Augmented Reality in Higher Education: A Bibliometric Analysis of Research Trends and Evolution from 1997 to 2024. *Journal of Technology-Assisted Learning, 1*(1), 92-114. https://doi.org/10.70232/jtal.v1i1.5

Summers, E.G. (1983). Bradford's Law and the retrieval of Reading Research Journal literature. *Reading Research Quarterly, 19*(1), 102-109

Sun, Y. L., Zhao, X. Y., Li, X. M., & Yu, F. Q. (2023). Effectiveness of the flipped classroom on self-efficacy among students: A meta-analysis. *Cogent Education*, 10(2). https://doi.org/10.1080/2331186X.2023.2287886

Teplitskiy, M., Duede, E., Menietti, M., & Lakhani, K. R. (2022). How status of research papers affects the way they are read and cited. *Research Policy*, *51*(4). https://doi.org/10.1016/j.respol.2022.104484

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies*, *28*(6), 6695–6726. https://doi.org/10.1007/s10639-022-11431-8

Tonbuloglu, B. (2023). State of research on e-assessment in education: a bibliometric analysis. *Turkish Online Journal of Distance Education*, *24*(4), 276–301. https://doi.org/10.17718/tojde.1184218

Triansyah, A., Yustiana, Y. R., Kurniawati, A., & Lukitowati, S. (2024). Bibliometric Analysis of Learning Models and Physical Education Based on Scopus Data. *Sustainable Jurnal Kajian Mutu Pendidikan*, *7*(1), 106–118. https://doi.org/10.32923/kjmp.v7i1.4463

Uzorka, A., & Olaniyan, A. O. (2025). Exploring Innovative Teaching Methods and Technologies in Ugandan Classrooms. *Journal of Research in Education and Pedagogy, 2*(2), 177-186. https://doi.org/10.70232/jrep.v2i2.43

Yu, M., Wang, Y., Yu, X., Shan, G., & Jin, Z. (2023). PubExplorer: An interactive analytical system for visualizing publication data. *Visual Informatics*, *7*(3), 65–74. https://doi.org/10.1016/j.visinf.2023.07.001

Zainuddin, Z., & Halili, S. H. (2016). Flipped classroom research and trends from different fields of study. *International Review of Research in Open and Distributed Learning*, *17*(3), 313–340. https://doi.org/10.19173/irrodl.v17i3.2274

Zhang, D., Men, H., & Zhang, Z. (2024). Assessing the stability of collaboration networks: A structural cohesion analysis perspective. *Journal of Informetrics*, *18*(1). https://doi.org/10.1016/j.joi.2024.101490

Zhang, Y., Wang, Y., Du, H., & Havlin, S. (2024). Delayed citation impact of interdisciplinary research. *Journal of Informetrics*, *18*(1). https://doi.org/10.1016/j.joi.2023.101468